ORP/SID 71-1

PB 211 479

RADIOACTIVE WASTE DISCHARGES TO THE ENVIRONMENT FROM NUCLEAR POWER FACILITIES

ADDENDUM-1

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TECHNICAL REPORTS

This report was originally prepared by the Division of Environmental Radiation, Bureau of Radiological Health, Department of Health, Education, and Welfare, with the first printing in March 1970. With the formation of the Environmental Protection Agency and the transfer of the Division of Environmental Radiation's staff and functions of this new Agency, the cover and title page have been changed accordingly for the printing of the first addendum.

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ORP/SID 71-1	Addendum-1 to BRH/DER 70-2, Radioactive Waste Discharges to the Environment from Nuclear Power Facilities

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Summarizes discharges of liquid and gaseous radioactive wastes from 13 nuclear power facilities. Includes discussion of sources, types, and trends of discharges, administrative controls, and operating experiences of the facilities. The report includes an appendix for each facility, describing characteristics of the plant and its discharge limits, and a brief operational history.

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ERRATA

Radioactive Waste Discharges to the Environment From Nuclear Power Facilities, Addendum - 1, ORP/SID 71-1.

Page 8, Table 5: Yankee (1970)

	Reads	Should Read
Total Gross Electrical Generation (MWe-hr)	($3.9X10^6$)	($1.3X10^6$)
μCi Discharges/MWe-hr Gross		
Liquid Gross β-γ less ^3H	(0.008)	(0.024)
Liquid Tritium	(360)	(1080)
Gaseous Gross β-γ	(4.2)	(12.6)

Page 25, Appendix IV

Items A.1.a., A.1.b., and A.1.c. require a change in the units for release rate from μCi/sec to Ci/sec.

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ORP/SID 71-1

RADIOACTIVE WASTE DISCHARGES TO THE ENVIRONMENT FROM NUCLEAR POWER FACILITIES

ADDENDUM-1 to BRH/DER 70-2

Joe E. Logsdon
and
Thomas L. Robinson

Surveillance and Inspection Division

OCTOBER 1971

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Radiation Programs
Washington, D.C. 20460

FOREWORD

The Office of Radiation Programs carries out a national program designed to evaluate the exposure of man to ionizing and non-ionizing radiation, and to promote development of controls necessary to protect the public health and safety.

Within the Office of Radiation Programs, the Surveillance and Inspection Division conducts programs relating to sources and levels of environmental radioactivity and the resulting population radiation dose. Reports of the findings are published in the monthly publication, Radiological Health Data and Reports, appropriate scientific journals, and Division technical reports.

The technical reports of the Surveillance and Inspection Division allow comprehensive and rapid publishing of the results of intramural and contract projects. The reports are distributed to State and local radiological health programs, Office of Radiation Programs technical and advisory committees, universities, libraries and information services, industry, hospitals, laboratories, schools, the press, and other interested groups and individuals. These reports are also included in the collections of the Library of Congress and the National Technical Information Service.

I encourage readers of these reports to inform the Office of Radiation Programs of any omissions or errors. Your additional comments or requests for further information are also solicited.

Joseph A. Lieberman
Deputy Assistant Administrator
for Radiation Programs

PREFACE

"Radioactive Waste Discharges to the Environment from Nuclear Power Facilities," to which this is an addendum, was issued in March 1970 by the U.S. Public Health Service, Bureau of Radiological Health, Division of Environmental Radiation. The Division of Environmental Radiation has since been transferred to the Environmental Protection Agency, Office of Radiation Programs, and is presently called the Surveillance and Inspection Division. Copies of the report, as well as this addendum, are available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

The report summarizes discharges through 1968 of liquid and gaseous radioactive wastes from nine nuclear power facilities. It also includes a general discussion of the sources, types and trends of liquid and gaseous wastes, the administrative controls, and the operating experience for the nine nuclear power stations included. Various tables and charts summarize the characteristics of the facilities and their discharges. This addendum to the report updates the tables and charts through 1970. It also provides data for one additional PWR, and three additional BWR plants: Robert E. Ginna (PWR), La Crosse (BWR), Nine Mile Point (BWR), and Oyster Creek (BWR).

The report includes an appendix for each facility, which describes the charactistics of the plant and its discharge limits, and provides a brief history of its operation. The appendices also includes graphs of discharges, power production, and maintenance operations as a function of time. This addendum provides appendices for the four additional facilities not included in the original report. However, the graphs of discharges, power production, and maintenance operations of the new facilities are not included in these appendices, because the plants have not operated long enough for trends to develop.

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RADIOACTIVE WASTE DISCHARGES TO THE ENVIRONMENT FROM NUCLEAR POWER FACILITIES

Addendum-1 to BRH/DER 70-2

INTRODUCTION

Nuclear power plants are continuing to increase in number and size, and their discharges of radioactive waste to the environment are being studied by the Environmental Protection Agency (EPA) to evaluate the potential for radiation exposure of the population. The original report, "Radioactive Waste Discharges to the Environment from Nuclear Power Facilities," to which this is an addendum, provided discharge data from operating nuclear power facilities through 1968. This addendum provides similar information for the years 1969 to 1970.

Most of the information in this addendum was taken from nuclear facility operator reports and follows the arrangement in the original report for consistency. The original report pointed out that reports by nuclear power facility operators generally did not include information concerning specific radionuclides discharged. Table 11 lists radionuclide releases for facilities which reported these data for 1970. Additional information on radionuclides in radioactive wastes from boiling-water reactors is available from a report on a special study (reference 11) by USPHS, Bureau of Radiological Health, around Dresden Nuclear Power Station. Similar studies have been performed by the EPA, Office of Radiation Programs, around two pressurized water reactors, Yankee and Connecticut Yankee. Reports of these two studies will be available toward the end of 1971.

Administrative Controls

The Atomic Energy Commission, Division of Regulation, has commented that their "routine compliance inspections conducted during the first half of 1971 indicated that sampling and analytical methods used at some nuclear power facilities were inappropriate to measure the total activity from all nuclides in liquid and gaseous effluents. Although there are no significant safety implications of the releases as determined by gross activity measurements, we are nonetheless pursuing the submission of revised estimates of effluent releases based on the licensees' knowledge of isotopic composition of the effluents. We anticipate that the corrected data will show different curie quantities as having been released during 1970 than those reported to AEC in the facility operating reports. Thus, the values in the 'Addendum' that were extracted from facility operating reports may be changed by the revised estimates. The licensees are required to report the revised effluent data as promptly as possible."

Other recent administrative changes include a proposed numerical guide for maintaining effluents as low as practicable. This guide would control effluents to levels approximately 1% of the current limits.

The above administrative modifications should provide better information on which to project population dose as a result of operating experience. The more detailed data should also permit more accurate projections of future population dose as facilities increase in density, size, and type, with overlapping areas of environmental influence.

Discussion of Data

Tables 1 and 2 duplicate tables in the original report, except that they include information on one additional PWR, Robert E. Ginna, and three additional BWRs, La Crosse, Nine Mile Point, and Oyster Creek. The only discernible trend in these two charts is that two of the BWRs are more than twice the size of any BWRs included in the original report. All of the BWRs and PWRs coming on line in the near future will be in the range of 500 to 1100 megawatts electrical.

The gross beta-gamma (less tritium) discharge data for liquids tabulated in table 3 show a general increase in discharge quantities since 1968 for most facilities. Exceptions include the Indian Point Station and the Humboldt Bay Power Plant Unit 3. Waste treatment practices are major factors in determining the quantity of radioactivity in liquid wastes available for discharge. Therefore, the reasons for reductions or increases in discharge quantities are generally not discernible from a review of the operating reports. However, the Indian Point Station was shut down for maintenance during most of 1970. This could have contributed to a reduction in discharge quantities.

The percentages expressed in table 4, in most cases, do not represent a true figure. This is because the discharge limit is a function of the concentration of individual radionuclides present in the waste; the limit becomes more restrictive with less analysis for specific radionuclides. Therefore, the percentages expressed in table 4 generally can be considered as representing less-than quantities.

Table 5 includes the same type of data as table 5 of the original report, but only for the years 1969 and 1970. The principal purpose of table 5 is to show discharges as a function of the amount of power produced by individual facilities. Comparison of 1969 and 1970 data on quantities discharged per unit of power generation to similar data in prior years shows a fairly steady ratio for individual facilities. Connecticut Yankee, which shows an increase of approximately a factor of 3, is an exception. A similar comparison of tritium in liquid discharges shows a decrease at Shippingport from 86 μCi/MWe in 1968 to 4.4 μCi/MWe in 1970. Connecticut Yankee showed an increase of

approximately a factor of 3 in tritium discharged per unit of power produced. Tritium discharges per unit of power produced at other facilities showed no particular trends.

Gaseous waste discharges per unit of power produced showed a factor of 40 decrease at Shippingport from 1968 to 1970, and a factor of 9 increase from 1968 to 1969 at Indian Point. The Indian Point facility was shut down during most of 1970 for maintenance, as mentioned. Some of these repairs (e.g., steam generator tube repairs) should result in reduced quantities of gaseous waste available for discharge in the future. Gaseous discharges per unit of power produced from San Onofre and Connecticut Yankee increased by factors of 140 and 175 respectively from 1968 to 1970. Reasons for these increases were not explained in the operating reports. Gaseous discharges per unit of power produced at other facilities showed no particular trends.

Figure 1 further summarizes the data in table 5, showing the liquid waste discharged from all facilities included in the report as a function of time in years in comparison with the total amount of power generated by these facilities. Similar curves are plotted for gaseous waste discharges with figure 2 representing BWR facilities and figure 3 representing PWR facilities. These curves show no dramatic improvement in control of waste discharges; however, they indicate some improvement during 1970.

Table 11 has been added to provide an indication of the radionuclides present in liquid and gaseous discharges. Most facilities do not routinely report discharges by individual radionuclide. Review of data in table 11 also shows that the facilities which do report radionuclide data have no consistent format. This situation should be corrected upon promulgation of the guides currently proposed by AEC.

TABLE 1. WASTE-PROCESSING CAPABILITY AT OPERATING NUCLEAR POWER FACILITIES

Reactor	Gaseous Waste Treatment			Liquid Waste Treatment
	Design Holdup or Delay Time	Particulate Treatment	Iodine Treatment	
PWRs				
Shippingport	60 days	none	none	filtration, evaporation, demineralization, gas scrubbing
Yankee	60 days	none	none	filtration, evaporation, demineralization
Indian Point-1	120 days	absolute filters	none	filtration, evaporation, demineralization, gas stripping
San Onofre	30 days	high efficiency filters	none	filtration, demineralization, gas stripping
Conn. Yankee	variable	fiberglass filter	none	evaporation, demineralization
Robert E. Ginna	45 days	filtration	none	filtration, evaporation, demineralization, gas stripping
BWRs				
Dresden-1	20 min.	absolute filters	none	filtration, evaporation, demineralization
Big Rock Point	30 min.	absolute filters	none	filtration, evaporation, demineralization
Humboldt Bay	18 min. design 40 min. actual	absolute filters	none	filtration, evaporation, demineralization
La Crosse	20 min.	none	none	filtration, evaporation, demineralization
Nine Mile Point	30 min.	absolute filters	none	filtration, demineralization
Oyster Creek	30 min.	absolute filters	none	filtration, evaporation, demineralization
HTGR				
Peach Bottom-1	variable	filtration	charcoal filters	demineralization

TABLE 2. GENERAL INFORMATION FOR FACILITIES INCLUDED IN THIS REPORT

Facility	AEC Docket No.	Power Level[6]		Location	Vent or Stack Height (Feet)	Vent or Stack Exhaust Rate (cfm)	Condenser Water for Dilution Flow Rate (gpm)	Body of Water Receiving Liquid Waste
		MWt	MWe Net					
PWRs								
Shippingport	None	505	90	Shippingport, Pa.	26[a]	9,000	114,000	Ohio River
Yankee	50-29	600	175	Rowe, Mass.	150	15,000	138,000	Deerfield River
Indian Point-1	50-3	615	265	Buchanan, N. Y.	400	280,000	300,000	Hudson River
San Onofre	50-206	1,347	430	San Clemente, Calif.	100	40,000	350,000	Pacific Ocean
Conn. Yankee	50-213	1,825	573	Haddam Neck, Conn.	175	70,000	372,000	Connecticut River
Robert E. Ginna	50-244	1,300	420	Rochester, N. Y.	150	NA	334,000	Lake Ontario
BWRs								
Dresden-1	50-10	700	200	Morris, Ill.	300	45,000	166,000	Illinois River
Big Rock Point	50-155	240	71	Charlevoix, Mich.	240	30,000	50,000	Lake Michigan
Humboldt Bay	50-133	240	68	Eureka, Calif.	250	12,000	100,000[b]	Humboldt Bay
La Crosse	115-5	165	50	Genoa, Wisc.	350	70,000	240,000[c]	Mississippi River
Nine Mile Point	50-220	1,538	500	Oswego, N. Y.	350	216,000	600,000	Lake Ontario
Oyster Creek	50-219	1,690	560	Toms River, N. J.	99	NA	640,000	Atlantic Ocean
HTGR								
Peach Bottom-1	50-171	115	40	Peach Bottom, Pa.	150	20,000	43,000	Susquehanna River

[a]Gas discharge stack; vapor container exhaust stack 116 feet.

[b]Flow rate for Humboldt Bay Unit 3 is 51,800 gpm. All calculations are based on a flow rate of 100,000 gpm which is the combined rate for Humboldt Bay Units 1, 2, and 3. Units 1 and 2 are fossil fuel plants.

[c]Includes 180,000 gpm from the Genoa #3 Fossil Station, which is connected to the LACBWR outfall.

NA, information not available.

TABLE 3. TOTAL ANNUAL LIQUID WASTE DISCHARGED[a]
GROSS β-γ LESS TRITIUM
(CURIES)

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
PWRs												
Shippingport[b]	0.083	0.21	0.129	0.09	0.19	0.53	0.14	0.06	0.07	0.08	0.208	0.07
Yankee			0.008	0.008	0.003	0.002	0.029	0.036	0.055	0.008	0.019	0.034
Indian Point-1				0.130	0.164	13.0	26.3	43.7[c]	28.0[d]	34.6[e]	28.0[e]	7.8
San Onofre									0.32	1.6	8.0	3.8
Conn. Yankee									0.216	3.9	12.8	22.0
Robert E. Ginna											0.017	9.02
BWRs												
Dresden-1		0.770	2.095	2.61	2.78	3.82	8.7	11.5	4.3[d]	6.1	9.5[e]	8.2
Big Rock Point[f]				0.2	0.63	6.22	2.80	6.12	10.1	7.9	11.81	4.64
Humboldt Bay					0.397	0.664	1.89	2.34	3.13	3.2	1.5	2.4
La Crosre											8.7[e]	6.46
Nine Mile Point											0.9[e]	9.44
Oyster Creek											0.48[e]	4.51
HTGR												
Peach Bottom-1									0.0017	0.0004	0.000185	0.0059

[a]Based on operators' reports except as noted.
[b]Data taken from Radiological Health Data and Reports.
[c]Data taken from reference 31.
[d]Data taken from reference 8.
[e]Data taken from reference 34.
[f]Data taken from reference 32.

TABLE 4. ANNUAL AVERAGE LIQUID RADIOACTIVE-WASTE DISCHARGE CONCENTRATIONS EXPRESSED AS PERCENT OF LIMIT[a]
(PERCENT OF DISCHARGE LIMIT EXCLUSIVE OF TRITIUM)

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
PWRs												
Shippingport	0.37	0.93	0.57	0.40	0.84	2.34	0.62	0.27	0.31	0.35	0.91	0.31
Yankee			0.03	0.03	0.01	0.007	0.1	0.13	0.02[b]	0.03	0.07	0.14
Indian Point-1				0.22	0.26	22.0	43.0	70.1	1.55[c]	1.65[d]	1.5[e]	0.28
San Onofre									0.46	3.1	12.8	6.2
Conn. Yankee									0.01[c]	5.35	1.4[f]	3.7
Robert E. Ginna											0.11[g]	4.5
BWRs												
Dresden-1		2.33	6.34	7.9	8.42	11.6	26.4	34.8	13.0	18.5	22.5	25.0
Big Rock Point				4.46	14.2	54.4	42.4	62.5	50.4[h]	82.3[i]	5.5[j]	3.1
Humboldt Bay					2.77	3.37	9.52	12.15	16.89	19.7	8.7	15.0
La Crosse											0.11	0.067
Nine Mile Point												21.0
Oyster Creek												17.0
HTGR												
Peach Bottom-1									0.02	0.005	0.002	0.15

[a] Percent of limit calculations were based on the following: (1) 10CFR20 limit for unidentified radionuclides in water of 10^{-7} μCi/ml except as noted, (2) average flow rates in the discharge canals equal to those given in table 2.

[b] Concentration limit 10×10^{-7} μCi/ml, based on radionuclide analysis.

[c] Concentration limit 30×10^{-7} μCi/ml, based on radionuclide analysis.

[d] Concentration limit 35×10^{-7} μCi/ml, based on radionuclide analysis.

[e] Concentration limit 37×10^{-7} μCi/ml, based on radionuclide analysis.

[f] Concentration limit 12×10^{-7} μCi/ml, based on radionuclide analysis.

[g] Concentration limit 3×10^{-7} μCi/ml, based on ^{131}I as principal radionuclide.

[h] Concentration limit 2×10^{-7} μCi/ml, based on radionuclide analysis.

[i] Concentration limit 1.5×10^{-7} μCi/ml, based on radionuclide analysis.

[j] Concentration limit 22×10^{-7} μCi/ml, based on ^{131}I as principal radionuclide.

TABLE 5. COMPARISON OF RADIOACTIVE-WASTE DISCHARGES TO ELECTRICAL POWER GENERATION

Facility and Reactor Type	Period Covered[a]	Total Waste Discharges During Period			Total Gross Electrical Generation (MWe-hr)	μCi Discharges/MWe-hr Gross		
		Liquid		Gaseous		Liquid		Gaseous
		Gross β-γ (Curies)	Tritium (Curies)	Gross β-γ (Curies)		Gross β-γ Less ^3H	Tritium	Gross β-γ
PWRs								
Shippingport	1969 (1970)	0.21 (0.071)	20 (1.71)	0.000075 (0.000019)	3.4×10^5 (3.9×10^5)	0.61 (0.18)	59 (4.4)	0.00022 (0.00005)
Yankee	1969 (1970)	0.019 (0.03)	1,225 (1,400)	4.14 (16.5)	1.2×10^6 (3.9×10^6)	0.016 (0.008)	1,020 (360)	3.45 (4.2)
Indian Point-1	1969 (1970)	28 (7.8)	1,100 (410)	600 (1,700)	1.8×10^6 (b)	15.5	611	333
San Onofre	1969 (1970)	8.0 (3.8)	3,531 (4,779)	256 (1,571)	2.8×10^6 (3.2×10^6)	2.86 (1.19)	1,260 (1,500)	91.5 (491)
Conn. Yankee	1969 (1970)	12.8 (22.0)	5,100 (7,370)	190 (702)	3.8×10^6 (3.7×10^6)	3.4 (5.95)	1,342 (1,900)	50 (189)
Robert E. Ginna	1969 (1970)	0.017 (9.02)	1.26 (106)	0 (10,070)	1.5×10^5 (2.3×10^6)	0.11 (3.87)	8.4 (45.4)	0 (4,322)
BWRs								
Dresden-1	1969 (1970)	9.5 (8.2)	6 (5.0)	8.6×10^6 (9.5×10^5)	8.7×10^6 (1.4×10^6)	11 (5.86)	6.9 (3.57)	9.9×10^5 (6.8×10^5)
Big Rock Point	1969 (1970)	11.8 (4.6)	28 (53.6)	2.0×10^5 (2.8×10^5)	4.2×10^5 (4.0×10^5)	28.1 (11.59)	67 (135)	4.8×10^5 (7.0×10^6)
Humboldt Bay	1969 (1970)	1.5 (2.4)	< 5 (< 7)	4.9×10^5 (5.4×10^5)	3.9×10^5 (4.3×10^6)	3.85 (5.58)	< 13 (< 16)	1.0×10^6 (1.2×10^6)
La Crosse	1969 (1970)	8.7 (6.46)	(19.8)	480 (700)	7.7×10^4 (1.3×10^5)	0.01 (48.21)	(148)	6.3×10^3 (5.2×10^3)
Nine Mile Point	1969 (1970)	0.897 (9.44)	(10)	55 (9,500)	7.1×10^4 (1.9×10^6)	0.001 (4.94)	(5.24)	7.8×10^2 (4.9×10^3)
Oyster Creek	1969 (1970)	0.481 (4.51)	5.066 (22.24)	7,000 (112,000)	3.5×10 (3.6×10^6)	1.37 (1.26)	14.5 (6.19)	2.0×10^4 (3.1×10^4)
HTGR								
Peach Bottom-1	1969 (1970)	0.0002 (0.0059)	40	71.5 (9.5)	1.5×10^6 (b)	0.001	257	476

[a]Data for 1970 in parentheses.
[b]Down for repairs.

TABLE 6. TOTAL ANNUAL LIQUID TRITIUM DISCHARGES[a] (CURIES)

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
PWRs													
Shippingport[b]	50.0	64.0	99.0	13.2	1.33	2.17	1.39	3.04	27.3	34.8	35.2	20.0	1.71
Yankee[c]				--	--	--	--	1,300	1,920	1,690	1,170	1,230	1,400
Indian Point-1					--	--	--	--	125[d]	297[d]	787[d]	1,100[e]	410
San Onofre										--	2,353	3,530	4,780
Conn. Yankee										221	1,740	5,100	7,370
Robert E. Ginna												1.26	106
BWRs													
Dresden-1			--	--	--	--	--	--	--	--	2.9[d]	6.0[e]	5.0
Big Rock Point					--	--	--	--	--	--	34[f]	28[e]	53.6
Humboldt Bay						214[g]	100[g]	54[g]	60[g]	166[g]	6.6[g]	< 5[e]	< 7
La Crosse													19.8
Nine Mile Point													10
Oyster Creek												5.066	22.2
HTGR													
Peach Bottom-1										--	Neg.[d]	40[e]	--

[a] Data taken from facility operating reports except as noted.

[b] Data for years 1958 through 1960 taken from Shippingport Operations from Power Operation after First Refueling to Second Refueling (May 1960 to August 16, 1961) DLCS-36402; data for years 1961 through 1970 taken from Radiological Health Data and Reports.

[c] Data taken from Yankee Nuclear Power Station Operation Report(s); tritium analysis was not included in the operating reports prior to 1965.

[d] Data taken from reference 8.

[e] Data taken from reference 34.

[f] Based on an upper limit calculation wherein all liquid waste released during 1968 was assumed to contain as much tritium as was in primary-system water.

[g] Data taken from P G & E records.

--, data not available.

TABLE 7. TRITIUM DISCHARGES IN LIQUID WASTES COMPARED TO AEC LIMITS[a]

	Average Discharge[b] Concentration μCi/ml			Percent of Limit		
	1968	1969	1970	1968	1969	1970
Pressurized Water Reactors						
Shippingport	1.6×10^{-7}	8.8×10^{-8}	7.5×10^{-9}	0.0053	0.003	0.0002
Yankee	4.5×10^{-6}	4.4×10^{-6}	5.1×10^{-6}	0.15	0.15	0.17
Indian Point-1	1.6×10^{-6}	1.8×10^{-6}	6.8×10^{-7}	0.045	0.06	0.02
San Onofre	5.0×10^{-6}	5×10^{-6}	6.9×10^{-6}	0.17	0.17	0.23
Conn. Yankee	2.4×10^{-6}	6.8×10^{-6}	1.0×10^{-5}	0.08	0.23	0.33
Robert E. Ginna		1.9×10^{-9}	1.6×10^{-7}		0.00006	0.05
Boiling Water Reactors						
Dresden-1	9×10^{-9}	1.8×10^{-8}	1.6×10^{-8}	0.0003	0.0006	0.005
Big Rock Point	3.6×10^{-7}	2.8×10^{-7}	5.4×10^{-7}	0.012	0.01	0.02
Humboldt Bay	$< 4.0 \times 10^{-8}$	$< 2.5 \times 10^{-8}$	$< 3.5 \times 10^{-9}$	0.0014	< 0.001	0.0001
La Crosse			4.2×10^{-8}			0.001
Nine Mile Point			8.3×10^{-9}			0.0003
Oyster Creek		4.3×10^{-8}	1.7×10^{-8}		0.001	0.0006
Gas Cooled Reactors						
Peach Bottom-1	Negligible	4.6×10^{-7}	NR	Negligible	0.03	

[a]Based on 10CFR20 limit for unrestricted areas on 3×10^{-3} μCi/cc and dilution in the condenser cooling water discharge canal.

[b]Calculated based on annual quantity of tritium discharged and the condenser cooling water flow rate.

NR, none reported.

TABLE 8. TOTAL ANNUAL GASEOUS WASTE DISCHARGED[a] (NOBLE AND ACTIVATION GASES) (CURIES)

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
PWRs												
Shippingport[b]	0.014	0.029	0.103	0.012	0.351	0.0024	0.032	0.030	0.002	0.001	0.000075	.000019
Yankee			0.00096	21.7	7.4	0.95	1.7	2.4	2.3	0.68	4.14	16.452
Indian Point-1				--	0.0072	13.2	33.1	36.4	23.4	59.7	600[c]	1700
San Onofre									4.02	4.83	256	1571
Conn. Yankee									0.021	3.74	190[c]	701.7
Robert E. Ginna											0	10070
BWRs												
Dresden-1[d]			34,800	284,000	71,600	521,000	610,000	736,000	260,000[e]	240,000	862,300	954,700
Big Rock Point[f]				25.6	803	783	132,000	705,000	264,000	232,000	200,000	277,000
Humboldt Bay[g]					716	5,975	197,000	282,000	896,000	853,000	492,000	535,200
La Crosse											480	700.02
Nine Mile Point											55	9,500
Oyster Creek											7,000	112,000
HTGR												
Peach Bottom-1								0.00126	7.76	109	71.5	9.5

[a] Based on operators' reports except as noted.
[b] Data taken from Radiological Health Data and Reports. Data corrected for 1963 and 1964 taken from reference 33.
Data taken from reference 34.

[d] Data from 1961 and 1962 based on maximum rate of noble fission gas activity discharged; data from 1963-1968 based on average activity discharge rate for the year while plant was operating.
[e] Data taken from reference 8.

[f] Data taken from reference 33.
[g] Data taken from P G & E records.
--, plant was operational but discharge data was not available.

TABLE 9. RELEASES OF HALOGENS AND PARTICULATES FROM POWER REACTORS IN GASEOUS EFFLUENTS

Facility and Type	Permissible[a] (Curies)	1969		1970	
		Released (Curies)	Permissible (%)	Released (Curies)	Permissible (%)
PWRs					
Yankee	0.03	< 0.0001	0.01	< 0.0001	0.03
Indian Point	7.6	0.025	0.33	0.075	0.98
San Onofre	0.8	< 0.0001	< 0.001	< 0.0001	< 0.001
Conn. Yankee	0.27	0.001	0.37	0.0004	0.001
Robert E. Ginna	1.7	< 0.0001	< 0.001	< 0.0001	< 0.001
BWRs					
Dresden-1	85.0	0.30	0.35	1.47	1.73
Big Rock Point	38.0	0.2	0.53	< 0.0001	< 0.001
Humboldt Bay	5.6	0.65	12.0	0.35	6.3
La Crosse	1.6	< 0.063	< 4.0	< 0.0001	< 0.001
Nine Mile Point	63.0	< 0.001	< 0.001	< 0.06	0.09
Oyster Creek	126.0	0.003	0.002	0.3	0.23
HTGR					
Peach Bottom-1	0.12	< 0.0006	< 0.5	< 0.0001	0.08

[a]Where the Technical Specifications do not state an annual limit for the iodines and particulates, an MPC value of 1×10^{-10} μCi/cc was used. This MPC is based on the most restrictive isotope normally found—^{131}I. The annual limit was reduced by a factor of 700 to account for reconcentration.

TABLE 10. ANNUAL GASEOUS RADIOACTIVE WASTE-DISCHARGES EXPRESSED AS PERCENT OF LIMIT[a]
(NOBLE AND ACTIVATION GASES)

	1959	1960	1961	1962	1963	1964	1965	1966	1967[b]	1968[b]	1969[c]	1970
PWRs												
Shippingport	0.035	0.073	0.26	0.03	0.87	0.006	0.08	0.075	0.005	0.0025	< 0.001	< 0.001
Yankee			0.000014	0.32	0.11	0.014	0.025	0.03:	0.036	0.008	0.063	0.24
Indian Point-1					4.5×10^{-7}	0.00083	0.0020	0.0022	0.0015	0.0037	0.01	0.03
San Onofre									0.0024	0.0003	0.014	0.28
Conn. Yankee									0.00003	0.0039	1.0	3.71
Robert E. Ginna											0	2.79
BWRs												
Dresden-1			0.158	1.29	0.32	2.37	2.77	3.34	0.87	1.09	3.91	5.41
Big Rock Point						0.0025	0.43	2.27	0.85	0.74	0.65	0.89
Humboldt Bay					0.045	0.38	12.5	17.8	56.7	54.0	31.2	34.30
La Crosse											0.1	0.14
Nine Mile Point											< 0.001	0.03
Oyster Creek											0.075	1.18
HTGR												
Peach Bottom-1								6.67×10^{-7}	0.04	0.087	0.38	37.49

[a] Percent of limit calculations were based on the following: (1) values as given in table 2 for stack flow rates and table 8 for annual quantities discharged, (2) discharge limits presented in appendices I through IX except as noted. In cases where the discharge limit is expressed as a factor times MPC and no MPC is given, then 3×10^{-8} μCi/cc is used.

[b] Limits for 1967 and 1968 from reference 8 except for Shippingport. Shippingport limits from reference 10 through 1969.

[c] Limits for 1969 based on reference 34.

TABLE 11. RADIONUCLIDES REPORTED IN WASTE DISCHARGES (1970)[a]

Radionuclides	Humboldt Bay (BWR) (Curies)	Conn. Yankee (PWR) (Curies)	Big Rock Point (BWR)	Nine Mile Point (BWR)	La Crosse (BWR)
Gaseous					
^{133}Xe	6,420[b]	603		160 μCi/sec	
^{133m}Xe	535[b]				
^{135}Xe	64,700[b]	84.6[c]		165 μCi/sec	
^{135m}Xe	82,900				
^{137}Xe	4,280				
^{138}Xe	217,000			75 μCi/sec	
^{83m}Kr	13,400				
^{85}Kr		9.76[c]			
^{85m}Kr	16,600[b]			38 μCi/sec	
^{87}Kr	73,300[b]			130 μCi/sec	
^{88}Kr	55,100[b]			110 μCi/sec	
^{89}Kr	535				
^{13}N				< 10 μCi/sec	(d)
^{41}Ar		2.7[c]			
Liquids					
^{51}Cr				60.0%	
^{54}Mn	0.24			5.9%	
^{58}Co		3.94		15.2%	(d)
^{60}Co	0.84	0.013		9.5%	(d)
^{65}Zn	0.12		42% of total		
^{59}Fe				9.0%	
^{131}I	0.09	0.25	(e)	0.4%	
^{137}Cs	0.84	0.10	(e)		
^{134}Cs	0.24		(e)		
^{89}Sr	0.01[f]				
^{90}Sr	0.01[f]				

[a]Includes only facilities which reported data on specific radionuclides other than tritium.
[b]These six nuclides are directly measured, the other gaseous nuclides are calculated.
[c]Expressed as ^{133}Xe equivalent.
[d]Reported as being present but without specific quantities.
[e]Activity was 42% ^{65}Zn. The remaining portion was mainly ^{134}Cs, ^{137}Cs, and ^{131}I.
[f]Conservative estimate.

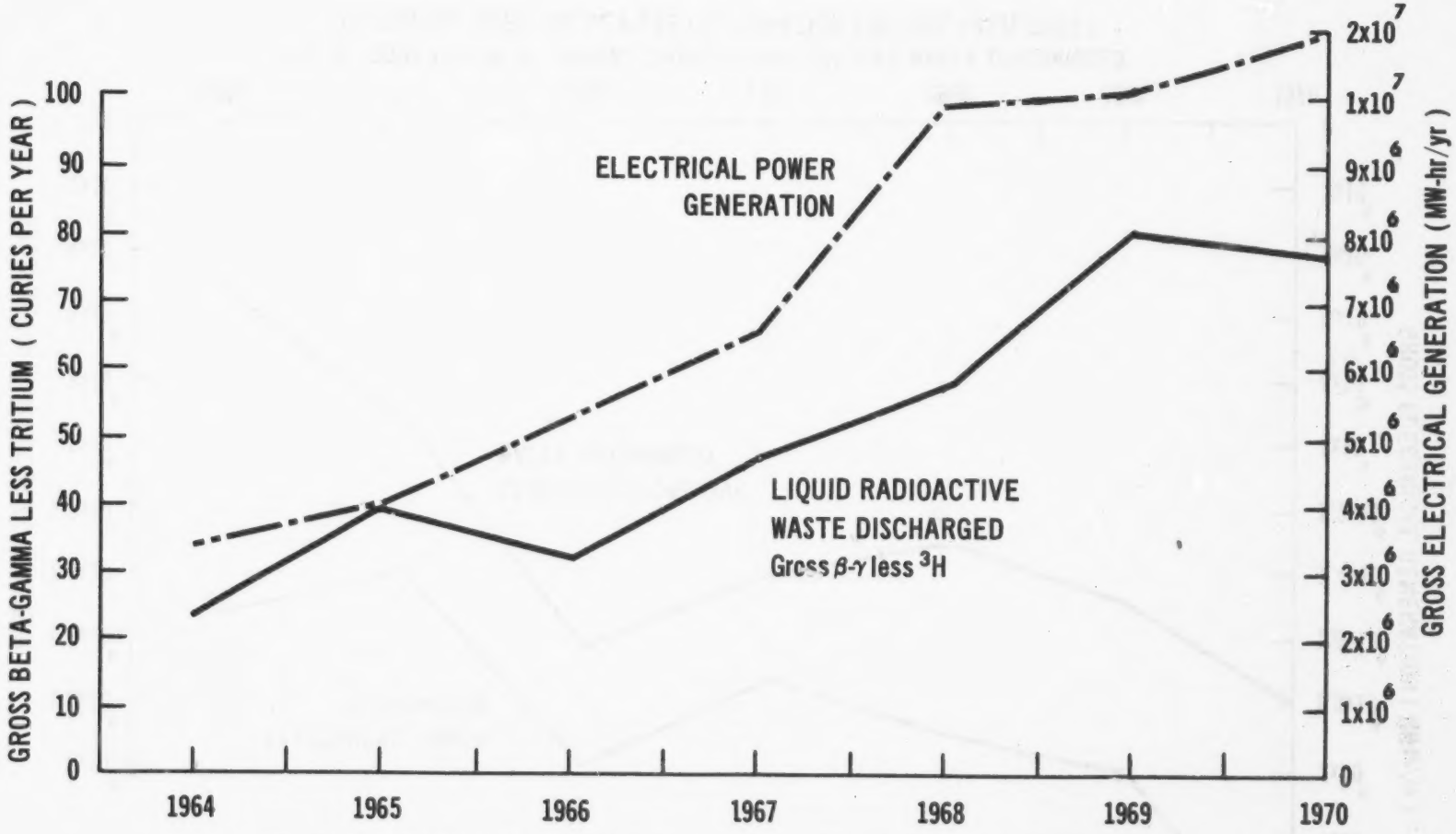

Fig. 1. COMPARISON OF ANNUAL LIQUID RADIOACTIVE WASTE DISCHARGED TO ANNUAL ELECTRICAL POWER GENERATION [a]

[a] Totals for all facilities included in this report.

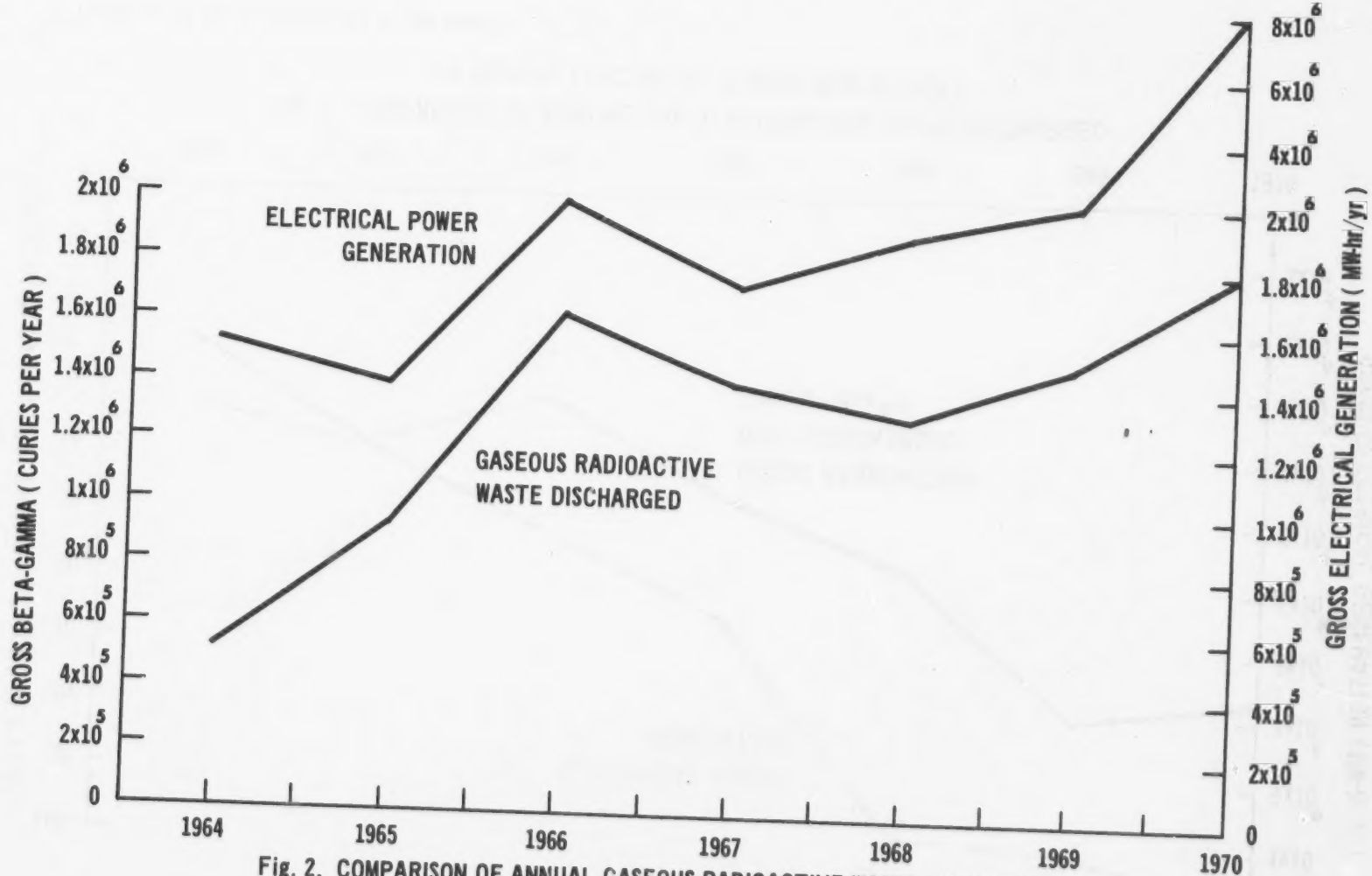

Fig. 2. COMPARISON OF ANNUAL GASEOUS RADIOACTIVE WASTE DISCHARGED TO ANNUAL ELECTRICAL POWER GENERATION FOR BWR FACILITIES [a]

[a] Includes all BWR facilities in table 5.

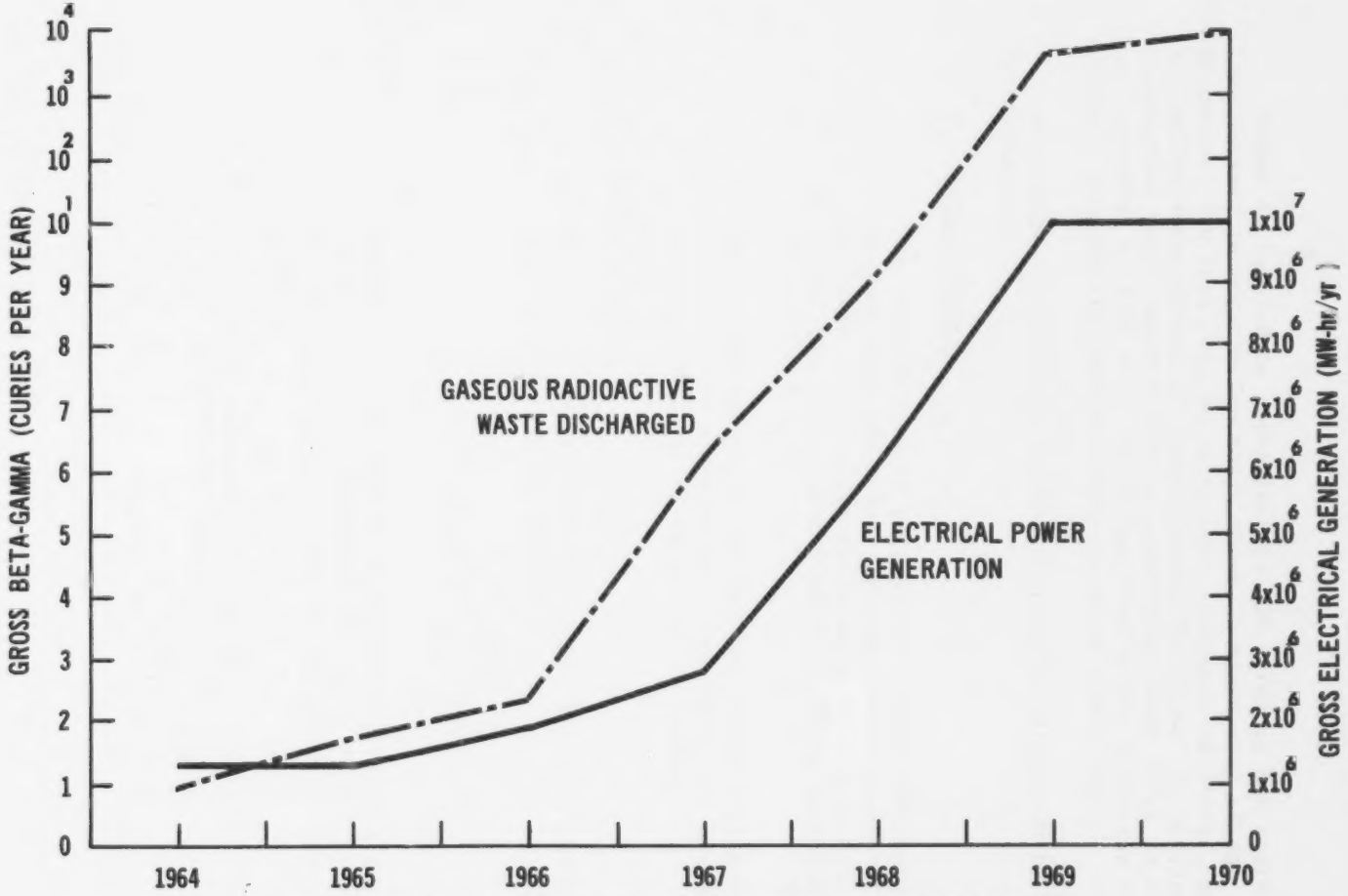

Fig. 3. COMPARISON OF ANNUAL GASEOUS RADIOACTIVE WASTE DISCHARGED TO ELECTRICAL POWER GENERATION FOR PWR FACILITIES [a]

[a] Includes all PWR facilities included in this report with exception of Indian Point Station, Unit 1.

APPENDIX I

ROBERT E. GINNA NUCLEAR POWER PLANT UNIT 1

Ginna is located on approximately 338 acres on the south shore of Lake Ontario in Ontario Township, about 16 miles east of the center of Rochester, New York, and 40 miles west-southwest of Oswego, New York, in the northwest corner of Wayne County, New York. It utilizes a pressurized water reactor with an authorized power level of 470 MWe, corresponding to 1410 MWt. It is operated by the Rochester Gas and Electric Corporation, and has been operating since 1969.

Discharge of effluents to the environment is limited by Technical Specifications:[36]

A. Liquid Wastes

1. The release rate of radioactive liquid effluents shall be such that the annual average concentration of radionuclides in the circulating water discharge does not exceed the limits specified in 10CFR20, appendix B, for unrestricted areas.

2. The concentration of radioactive liquid effluents when averaged over a period of 1 hour shall not exceed 10 times the MPC values specified in 10CFR20.

B. Gaseous Wastes

1. The annual average release rates of gaseous wastes shall be limited as follows:

$$2.5 \times 10^{-6} \ (\text{sec/m}^3) \times \sum \frac{Q_i}{(\text{MPC})_i} \leq 1.0$$

where Q_i is the annual release rate (Ci/sec) of any radioisotope, i, and $(\text{MPC})_i$ in units of μCi/cc are defined in column 1, table II of appendix B to 10CFR20.

2. The maximum release rate over any 1 hour shall not exceed 10 times the yearly average limit.

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APPENDIX II

LA CROSSE BOILING-WATER REACTOR

La Crosse is located on the east bank of the Mississippi River in Vernon County, Wisconsin, approximately 1 mile south of the village of Genoa, Wisconsin, and approximately 19 miles south of the city of La Crosse, Wisconsin. It utilizes a boiling-water reactor manufactured by Allis Chalmers Manufacturing Corporation, with an authorized power level of 50 MWe which corresponds to 165 MWt. It is operated by the Dairyland Power Cooperative and has been operating since 1967. Operating difficulties and additional test programs delayed full power operations until September, 1969.

Discharges of radioactivity to the environment are limited by Technical Specifications:[38]

A. Liquid Wastes

All liquid waste system radioactive effluents shall be batch-sampled and analyzed prior to release and are limited to concentrations specified in appendix B of 10CFR20.

B. Gaseous Wastes

Disposal of the radioactive gaseous waste shall be through the stack, with at least 1 stack blower in operation. The discharge rates shall not exceed the limits in the following chart. The maximum permissible concentrations (MPC in microcuries per ml) shown in this chart are for individual isotopes and mixtures listed in column 1, table II, appendix B of 10CFR20.

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CHART OF GASEOUS RELEASE LIMITS

Type of Activity	Maximum Ci/sec to be Released	Maximum Ci/sec to be Released (averaged over 1 year)
Two-blower Operation		
Particulate matter and halogens with half-lives longer than 8 days	$5.1 \times 10^{3} \times$ MPC	$5.1 \times 10^{2} \times$ MPC
All other radioactive isotopes	$3.4 \times 10^{6} \times$ MPC	$3.4 \times 10^{5} \times$ MPC
One-blower Operation		
Particulate matter and halogens with half-lives longer than 8 days	$2.4 \times 10^{3} \times$ MPC	$2.4 \times 10^{2} \times$ MPC
All other radioactive isotopes	$1.6 \times 10^{6} \times$ MPC	$1.6 \times 10^{5} \times$ MPC

APPENDIX III

NINE MILE POINT NUCLEAR STATION

Nine Mile Point is located on approximately 1500 acres on the southeast shore of Lake Ontario in Oswego County, New York. It utilizes a boiling-water reactor with an authorized power level of 600 MWe, which corresponds to 1800 MWt. It is operated by the Niagara Mohawk Power Company and has been in operation since 1969.

Discharges of radioactivity to the environment are limited by Technical Specifications:[37]

A. Stack Release

1. The maximum release rates of gross activity, except iodines and particulates with half-lives longer than 8 days, shall be limited in accordance with the following equation:

$$Q \leq \frac{0.57}{\bar{E}} \text{ (Ci/sec)}$$

where Q is the stack release rate (Ci/sec) of gross activity and $\bar{E}$ is the average gamma energy per disintegration (MeV/dis).

2. The maximum release rate of iodines and particulates with half-lives longer than 8 days shall be limited in accordance with the following equation:

$$Q \leq 1.5 \times 10^4 \text{ MPC}_i \text{ (Ci/sec)}$$

where Q is the stack release rate (Ci/sec) of iodines and particulates with half-lives longer than 8 days and MPC_i ($\mu\text{Ci/m}^3$) is the maximum permissible concentration in air as defined in column 1, table II, of appendix B and note 1 thereto of 10CFR20.

B. Liquid Effluent

1. The concentration of gross beta activity (above background) in the condenser cooling water discharge canal shall not exceed the limits stated below unless

the discharge is controlled on a radionuclide basis in accordance with appendix B, table II, column 2, of 10CFR20 and note 1 thereto:

maximum concentration (excluding tritium)

1×10^{-7} μCi/ml

maximum tritium concentration

3×10^{-3} μCi/ml .

APPENDIX IV

OYSTER CREEK NUCLEAR POWER PLANT UNIT 1

Oyster Creek is located on approximately 800 acres on the Atlantic coast of New Jersey. It is partly in Lacey and partly in Ocean Township of Ocean County, New Jersey, about 2 miles inland from the shore of Barnegat Bay. It utilizes a boiling-water reactor with an authorized power level of 640 MWe, which corresponds to 1920 MWt. Operator is the Jersey Central Power and Light Company. The plant has been operating since 1969.

Discharges of radioactivity to the environment are limited by the following Technical Specifications:[35]

A. Plant Stack Effluents

1. The release rate of radioactive effluents from the plant stack shall not exceed the following:

   a. The annual average continuous release rate of radioactivity, except halogens and particulates with a half-life greater than 8 days, shall not exceed 0.3 μCi/sec.

   b. The release rate of radioactivity, except halogens and particulates with a half-life greater than 8 days, shall not exceed 1.0 μCi/sec for a period in excess of 48 hours in any 7 consecutive days.

   c. The release rate of radioactivity, except halogens and particulates with a half-life greater than 8 days, shall not exceed 3.0 μCi/sec for a period in excess of 15 minutes in any 1 hour.

   d. The annual average continuous release rate of radioactive halogens and particulates with a half-life greater than 8 days shall not exceed 4 μCi/sec.

   e. The release rate of radioactive halogens and particulates with a half-life greater than 8 days shall not exceed 13 μCi/sec for a period in excess of any 7 consecutive days.

B. Discharge Canal Effluents

1. The release rate of radioactive liquid effluents shall be such that the concentration in the discharge canal at the site boundary shall not exceed the following:

   a. The annual average concentration of unidentified radionuclides shall not exceed 1×10^{-7} μCi/cc.

   b. The annual average concentration of tritium shall not exceed 3×10^{-3} μCi/cc.

   c. The ratio obtained by dividing the annual average concentration of unidentified radionuclides (μCi/cc) by the unidentified mixture limit of 1×10^{-7} μCi/cc when added to the ratio obtained by dividing the annual average concentration of tritium (μCi/cc) by the tritium limit of 3×10^{-3} μCi/cc shall not be greater than one.

   d. The concentration of radioactive liquid effluents when averaged over a period of 1 day shall not exceed 10 times the values permitted in a), b), and c) above.

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RADIOACTIVE WASTE DISCHARGES TO THE ENVIRONMENT FROM NUCLEAR POWER FACILITIES, ADDENDUM-1 (ORP/SID 71-1) by Joe E. Logsdon and Thomas L. Robinson; October 1971; SID, ORP, EPA

Accession No.

This addendum summarizes discharges through 1970 of liquid and gaseous radioactive wastes from 13 nuclear power facilities. Discharges are compared to power production.

KEY WORDS:
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RADIOACTIVE WASTE DISCHARGES TO THE ENVIRONMENT FROM NUCLEAR POWER FACILITIES, ADDENDUM-1 (ORP/SID 71-1) by Joe E. Logsdon and Thomas L. Robinson; October 1971; SID, ORP, EPA

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